Digital Fabrication as an opportunity for social transformation in Cali Colombia

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Summary: Fablabs, or digital manufacturing laboratories, are spaces of exploration and inquiry where new applications and implications of technology are investigated with a practical sense, applied in context, in function of social transformation, technological appropriation and entrepreneurship. The maker movement is an association of inventors, designers, thinkers, handcrafters, hackers and technology enthusiasts who seek to solve their everyday problems by using technology under a cooperative and collaborative philosophy. As access to these technologies is democratized, more and more people will be able to materialize their ideas, personalize their products and even redesign their processes to achieve a social transformation based on the application of these technologies to solve the problems of each community. This panel aims to show how these initiatives contribute to innovation through the generation of technological solutions, the democratization of technology within the reach of educational communities, and collaborative work in Latin America and the World.
Keywords: Digital Manufacturing, Innovation, Maker, Social Transformation Movement.

Introduction

The Maker movement origins can be traced back to the culture of constructivism, the artistic spirit of craftsmanship, and the autonomy and curiosityof the “The Do It Yourself”, or DIY for its acronym in English. Due to the democratization of technology mainly because of the capitalism, and advanced technological know-how by scientific advances, digital technologies and tools for design and manufacturing, electronic prototyping and digital media documentation are increasingly accessible, allowing knowledge and procedures to be shared in ways never before seen. The maker culture is based on collaboration, and its principles include doing, sharing, giving, learning, playing, participating, learning, and changing. Doing is a fundamental part of human beings, what differentiates us from the rest of nature is the ability to do and create to make our lives easier, and when done under a collaborative philosophy where the community and not the individual primes, the changes and results are bound to achieve a social transformation.

The maker culture connects advances in technology with the artisan, the cultural and creative skills of communities with the power of machines, strengthening essential 21st century skills such as teamwork, problem solving, creativity, experimentation, entrepreneurship and leadership that are fundamental in learning, hence its importance and relevance.

Jean Pieaget, considered the father of constructivism, says that "the main objective of education should be to create men capable of doing new things, not simply repeating what other generations have already done", which marks the importance of strengthening a culture in which things are done as a mean for learning. Within a digital manufacturing space there are 3 key elements: access to digital tools, community development, and maker philosophy. The latter is the most important, because only those who want to do something for an intrinsic motivation are those who are willing to try, and both access to tools and the community, are guaranteed by the creation of these spaces. Technological advancement and globalized economies allow students to have access to great information resources on how to do anything from anywhere in the world, the only thing they require is the opportunity to do so.

Educational innovation refers to "a set of ideas, processes and strategies, more or less systematized, through which it is intended to introduce and cause changes in current educational practices. Innovation is not a punctual activity but a process, a long journey that stops to contemplate the classrooms experience, the organization of the centers, schools, or universities, the dynamics of the educational community and the professional culture of the teaching staff. Its purpose is to alter the current reality, modifying conceptions and attitudes, altering methods and interventions and improving or transforming, as appropriate, teaching and learning processes. Innovation, therefore, is associated with change and has a component - explicit or hidden - ideological, cognitive, ethical and affective. According to Jaime Carbonell (CAÑAL LION, 2002: 11-12) innovation appeals to the subjectivity of the subject and the development of their individuality as well as to the practical theoretic relations inherent to the educational practice.

Educational innovation seeks to discover new forms of teaching and learning through the inclusion of new tools and processes that transform the experience of the actors involved and improve the quality of their results in the light of criteria of effectiveness, quality, functionality, justice and social freedom.

Currently, various projects worldwide recognize the importance of innovation and culture maker and its potential for social and educational transformation. The fablabs are a worldwide network of laboratories that began in 2004 at the Massachusetts Institute of Technology's Bit and Atom Center, whose premise is the democratization of technology for solving local problems, under a network of knowledge and experts willing to collaborate. Currently, this network has more than 1100 laboratories, in more than 100 countries worldwide. The Digital MediaLabs and the MakerSpaces are spaces that put different technological resources to the service of the community to be used freely for the experimentation, the entertainment and the collaboration, and serve as meeting point of creative minds for the development of their projects. These spaces have generated several groups of experts and professors who study their impact on education, in which 2 projects arise: the Transformative Learning Technologies Laboratory (TLTL), a multidisciplinary group that analyzes the impact in teaching of science, technology, engineering and mathematics in schools, and FabLearn, a network of collaboration and research on how the use of digital manufacturing technologies helps the development of 21st century skills.

Given this worldwide trend, the Faculty of Engineering of the Universidad Autonoma de Occidente has created 3 spaces aligned with this same vision. The Fablab Cali is the first academic Fablab of Colombia that is part of the worldwide network of fablabs. Founded in 2012, it has developed several projects that contribute to the creation of value in the teaching, extension and social projection lines, where the techniques of virtual prototyping and the way of passing from the bits, digital, to the Atoms, physical, are studied. Expin MediaLab seeks to create spaces for reflection on the use, integration and creative articulation of technology, science and art for its implementation in different social fields for the production, diffusion and incorporation of digital culture and technology in the regional and social context. The Innolab, Innovation Laboratory of the Universidad Autonoma de Occidente, is a space where knowledge, experiences, practices, interventions and others techniques are combined, with the purpose of stimulating students, teachers and communities to use creative thinking and innovation as a transformation tool, as well as fostering the discovery of alternatives for improvement for the different challenges and problems present in today's world through the application of innovative ideas. This platform of laboratories and spaces led by experts allow the development of activities of exploration, experimentation, research, reflection, internal and external articulation, as well as transfer of methodologies and practices to the community.

This paper evidences some of the projects and works developed in these laboratories, where the impact and the social transformation with a focus in social innovation can be achieved by working collaboratively in hybrid spaces between digital fabrication laboratories and the Media Labs.

User-Centered Design and Prototyping

As the first activity of the laboratory of innovation, the student group of the lab participated in the IDEO virtual courses of user-centered design and prototyping. In these courses the techniques of Design Thinking for social transformation were applied and the work done with a community of mothers of a neighborhood in Cali, Colombia, and a group of users of the foundation of the Universidad Autonoma de Occidente, who have a group of stilts made by hand were used as experience. With the community of mothers, a concept of an art coffee was conceived, where artists, designers and communitarian mothers merge with a café that allows the display of co-created products. Figure 1 show the results of these processes, where students were certified in both courses.

Figure 1. User-Centered Design Course and Prototyping

Digital Manufactured Lanterns

This project was made in Siloé, a vulnerable neighborhood in Cali, with a community mothers from the cultural center. As is customary in most Latin American countries, by December 7, on the day of

the candles, lanterns are made, and many people take advantage of these as an entrepreneurship option. This was the case of community mothers, who were developing lanterns manually, using recycled bottles as an input. As shown in Figure 2, the manual process consisted of manually tracing the previously printed images, and then using a soldering iron to cut the designs, which were then hand painted. The manufacturing process, not including the decoration, on average, was 4 hours per lantern, and the total production of the group was about 80 lanterns. With this manual process of manufacture, community mothers exposed themselves to burn their hands, and being so manual, the repetitiveness of the lanterns was very low.

Figure 2. Manual Process Manufacturing Lanterns

As part of the social projection policy, this group of mothers was invited to a workshop on ideation and approach to technology at the university, at the Fablab Cali. After this workshop, mothers learned about laser cutting and digital manufacturing, and saw the option of creating lanterns with this technology. A pilot test was carried out, and a lantern was created in less than 2 minutes, cutting the plastic bottle on a rotating shaft to achieve the cut, obtaining the same cut at all times, as can be seen in figure 3.

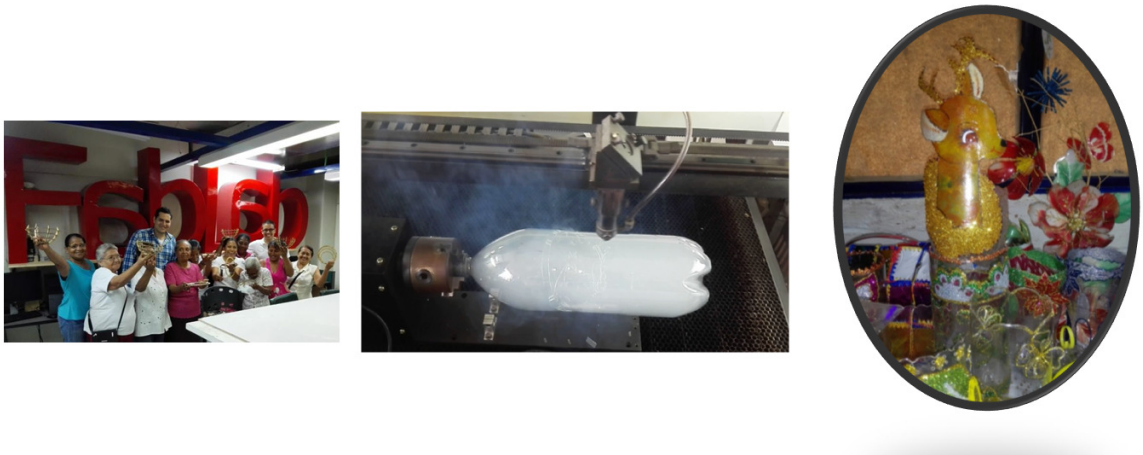

Figure 3. Digital Lantern Manufacturing Process.

The mothers could not believe the ease of this process, and they went back to their community very excited thinking about the possibilities. A week later they approached the Fablab again, asking for collaboration to cut some more bottles. The mothers understood the potential of the technology, and started a campaign in the neighborhood to collect bottles and make their lanterns. Siloé is a

neighborhood on a hill in the south west of Cali, where drugs and criminality proliferate, which is why there are many gangs that fill the neighborhood with invisible borders. However, most of its residents are law-abiding citizens, but because of the lack of opportunities, young people are forced to join these gangs. Community mothers saw in these lanterns the opportunity to raise a voice of protest and try to eliminate these invisible borders, as they did the bottle-picking campaign, the gang members were intrigued and wanted to know why where they collecting the bottles, and when the head of a gang asked the leader of the mothers, they invited them to participate in the creation of the lanterns to be able to illuminate the whole neighborhood. After the campaign, they collected more than 400 bottles, which at a rate of 4 hours per bottle, would be about 66 days of manual cutting, but with the use of technology, they were cut in 2 evenings, with much more detailed designs and precise than those that could have been done manually. The group of mothers then taught the gangsters to finish the bottles and decorate them manually, and with all these lanterns, managed to illuminate the whole neighborhood. For one day, on December 7, 2015, invisible borders disappeared from the neighborhood and mothers demonstrated that with good ideas, after a process of ideation and identification of innovation opportunities, through digital manufacturing, society can be transformed.

Thanks to this example and the dynamics of the Universidad Autonoma de Occidente, with the community Library center of the neighborhood and the Bibliotec foundation, it was possible to articulate a project for the creation of a Makerlab in the neighborhood, which consists of laser machines, as the one used in the manufacturing of lanterns, 3d printers, robotics, electronics and audiovisual media kits, from which the community has appropriated and created and strengthened the robotics and audio-visual clubs, and the entrepreneurship of community mothers and Community in general. The impact of these spaces is invaluable, since the community in general has appropriated space and children who were previously at home exposed to start their criminal life with gangs, now spend every afternoon in this space where they can materialize their ideas and learn about cutting-edge technology that match their specific needs.

Robotics from recycled elements

In the innovation laboratory, with the creativity and innovation student group, it was identified that the development of robotic kits made from recycled elements for children was an opportunity to strengthen the robotics groups in the communities, and additionally, that students of fourth and fifth semester in engineering to apply the knowledge acquired in their careers as Electronics and Mechatronics students. For that, a non-school training space called complementary activity was used, where engineering students have 2 academic credits to develop projects that complement their training as engineers, and an activity was proposed which purpose was to involve students in activities related to robotics. The goal was to generate a kit for children that used recycled obsolete computer parts such as floppy disk drives, cd's, dvd's, and others. To validate the kits, students should try them with the kids at “Roboteando Aprendo”, a group of robotics in Siloe. To carry out this work, students recognized the importance of assuming with responsibility and discipline a process of self-management formation to achieve autonomous and continuous learning, identifying their particular learning style and pace, to reinforce, find or construct new knowledge and skills, understand and analyze the validity of ideas, arguments, evidences and reasoning with clear and objective criteria, to confront, assume a position and make value judgments, validating in the field with real users to validate their designs. Students were responsible for designing, prototyping, performing, validating and improving the kits using free software tools, and complemented the designs with pieces made by digital manufacturing, obtaining kits and results such as those shown in figure 4.

Figure 4. Robotic Kits for Children from Recycled Elements

This is a clear example of how, through innovation and digital manufacturing, a group of university students can create a learning experience for school children, developing their skills of autonomy, creativity, social responsibility and relevance, motivation and the introduction in scientific subjects for children who learn about circuits and robotics using recycled materials.

OpenFab. Digital Manufacturing for All

Another of the training activities that took place in this non-school space called complementary activity was called "OpenFab. Digital fabrication for All ". The purpose was to instruct and train students in digital manufacturing tools and collaborative design, where students learned how to use Fablab's machinery and support the development of the OpenFab, an open workspace in the FabLab Cali where students can come to the different sessions of practice they prefer, without being a prerequisite to have participated in the previous sessions or to comply with a mandatory registration of attendance. In the OpenFab, an expert explains the operation of the different equipment available, and each student makes use of them to develop a class project. The practice consisted in learning about the workflow for the different machines to support and collaborate with their peers during the

space, and in addition the development of use guides and examples that later serve as tutorials to share to those who could not attend. Currently, these generated reference guides are a collaborative document that is improving after each iteration for a better understanding, and are available to all to learn about digital manufacturing. Figure 5 shows the advertising of space for the entire community of Cali.

Figure 5. OpenFab Advertising 2017

MakerGirls. Encouraging the participation of Girls in Engineering.

This activity is focused on addressing the challenges of engineering education for the female gender, which has been of great attention and study worldwide because engineering is the field most dominated by the male gender in the field of STEM (Science, Technology, Engineering and Maths). The activity is oriented to make a revision of methodologies and pedagogical strategies for the teaching of robotics with an approach that allows to awaken and to cultivate the interest of the girls in the STEM area. To begin, the students made a research and data collection of the current state of aspects such as the inclusion of gender in the middle and higher education in engineering, in order to know trends and strategies at national and international level and make proposals more contextualized to our environment. Subsequently, they designed and executed a pilot experience of articulation between the University and a private female college in the region, about robotics initiation, reflecting on the curricular requirements needed in a course of this type. Under the guidance of the Innolab, the participants accompanied the girls with ideas, identified opportunities and generated ideas of activities, materials and resources for initiation in electronics, digital fabrication and programming of girls between the ages of 9-16 to strengthen skills in problem solving, Technological culture, teamwork and also maximize their potential for girls in the STEM (Science, Technology, Engineering and Maths) area.

Figure 6 shows evidence of some of the electronics and robotics workshops with girls at a private school in the region. In these workshops, the girls learned about 3D modeling, programming in

Scratch, Basic Electronics with LittleBits, and developed projects in Arduino and SnapArduino, which they presented in the science fair of the school in its version 2017. With this project it is possible to encourage in Girls interest in these issues, to increase the numbers of girls entering engineering and mathematics faculties.

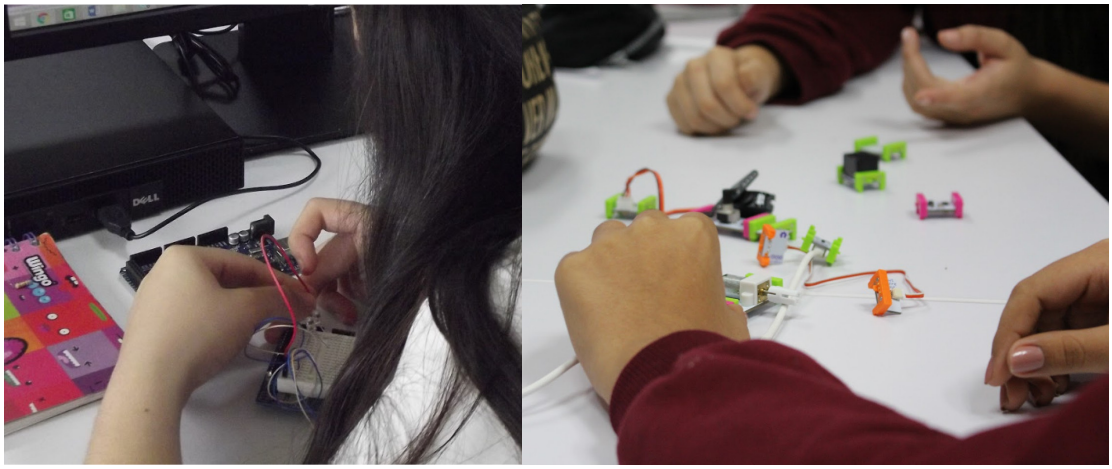

Figure 6. Electronics Workshop with Girls.

CONCLUSIONS

Some examples of how, working together from innovation and digital fabrication processes can be articulated to result in real opportunities for social transformation. They showed examples of how to work hand in hand with the community, and how to use these spaces for the creation of academic spaces where university students apply the theoretical concepts learned in classes, in a real environment with the community.

Facilitate community access to digital manufacturing spaces and medialabs, allow empowerment and willingness to solve their needs and work collaboratively among community, experts, academics and companies. Continuing this long-term initiative contributes to innovation through the generation of technological solutions, the democratization of technology and knowledge within the reach of communities and organizations, and collaborative work.

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